DOCUMENT RESUME

ED 071 450 EM 010 701

AUTHOR	Fletcher, J. D..; And Others
TITLE	A Note on the Effectiveness of Computer-Assisted Instruction.
INSTITUTION	Stanford Univ., Calif. Inst. for Mathematical Studies in Social Science.
PUB DATE	6 Dec 72
NOTE	11p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Annotated Bibliographies; Compensatory Education; *Computer Assisted Instruction; Cost Effectiveness; Educational Methods; *Elementary Education; *Evaluation; Higher Education; Program Costs; *Secondary Education

ABSTRACT

Though the Coleman Report stated that factors within the schools seem to affect achievement much less than factors outside the schools, this report suggests that there are strong and consistent achievement gains by students when they are given computer-assisted instruction (CAI) over a reasonable fraction of a school year. Supporting this claim is an annotated listing of 16 studies that discuss CAI programs that have been effectively used. The programs include all levels of instruction and a wide range of curricular subject: mathematics, science, nursing, and languages. The authors report that the current literature reveals practically no negative findings in CAI evaluations. (MC)

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J. D. Fletcher, P. Suppes, and D. T. Jamison

Stanford University

December 6, 1972

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INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES

STANFORD UNIVERSITY

STANFORD, CALIFORNIA

ERIC 701

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J. D. Fletcher, P. Suppes, and D. T. Jamison

Stanford University

There is a current view that what goes on in schools has little effect on the achievement of students. This view received considerable support from the Coleman Report (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, and York, 1966) and from Jensen (1969). Coleman concluded that factors within the schools seem to effect achievement much less than do factors outside the schools; these somewhat disheartening conclusions have been subject to rather rigorous debate since their initial publication.

Our own work, however, has led us to more optimistic conclusions concerning the potential capability of the schools to affect scholastic performance. We have found strong and consistent achievement gains by students when they are given CAI over a reasonable fraction of a school year. As Bowles and Levin (1968) pointed out: "The findings of the Report are particularly inappropriate for assessing the likely effects of radical changes in the level and compositions of resources devoted to schooling because the range of variation in most school inputs in this sample is much more limited than the range of policy measures currently under discussion." Many evaluations of CAI provide detailed information about the output effects of a much broader variety of school inputs than the Coleman Report considered.

CAI can be used or abused. The point we want to make is that CAI is an extremely effective pedagogical tool and that used properly, it

presents a serious possibility for the improvement of education. The following sample of CAI evaluations, however wide in geographical distribution and diverse in application, all discuss CAI programs that have been effectively used.

Suppes and Morningstar (1969) reported an evaluation of mathematics drill-and-practice programs for grades one through six in a Mississippi school for the academic year 1967-68. In each of the six grades, the improvement in grade placement achieved by students randomly assigned to CAI was significantly greater ($p < .01$) than that achieved by control students. The differences in grade placement improvement ranged from .41 to .88 in favor of the CAI students.

Beech, McClelland, Horowitz, and Forlano (1970) reported an extensive investigation of the attitudes of parents and students toward the Dial-A-Drill mathematics program used in New York City. The attitudes of parents toward the program were quite positive, and a questionnaire directed to the students elicited an equally favorable response. The results are of some interest because the parents and children were all drawn from poverty areas.

Two studies have related arithmetic achievement to amount of CAI, using linear regression models. Jamison, Wells, and Whelchel (1973) analyzed data for over 400 fifth and sixth grade students. Their results indicated, for example, that for fifth grade boys taking 150 ten-minute CAI sessions per year, slightly less than one session per day, would result in a grade placement gain of .58 years. The gain would result solely from the CAI intervention independent of any gain attributable to classroom instruction or the interaction between classroom instruction and CAI.

Suppes, Fletcher, Zanotti, Lorton, and Searle (1973) reported a 1971-72 study that provided mathematics CAI to elementary and secondary school students in residential schools and day classes for 312 deaf students. In reporting the effect of CAI on grade placement gains for this population, Suppes, et al. demonstrate that assuming 150 ten-minute CAI sessions per school year, a grade placement gain of 1.26 years can be expected and attributable to the CAI intervention. In general, this report appears to corroborate the subjective impression of many investigators that CAI is most effective when it is used by students who are below grade level.

Atkinson (1968) reported an evaluation of initial reading CAI using very elaborate CAI terminals. Students assigned to CAI groups achieved significantly greater gains in reading grade placement on the California Achievement Test and on a test developed by the project than did students receiving only classroom instruction.

An evaluation of a newer CAI program in initial reading that uses only teletypewriter terminals and digitized audio is reported by Fletcher and Atkinson (1972). The study used 50 matched pairs of first grade students with one member of each pair assigned to CAI. After one year, the CAI students achieved an average reading grade placement of 2.3 on the Stanford Achievement Test and 2.6 on the California Cooperative Primary Test compared with 1.9 and 2.1 achieved, respectively, by the non-CAI students. Both these differences are statistically significant.

Additionally, both Atkinson (1968) and Fletcher and Atkinson (1972) report that boys did as well as girls under the CAI treatment. This result is directly contrary to the long-established expectation of superior performance by girls in initial reading.

In discussing the intensity of CAI instruction or amount of instruction provided per unit time, Fletcher and Suppes (1972) point out that students received about twice as many new vocabulary words in a CAI reading program as did students receiving classroom instruction, again assuming 150 ten-minute sessions per year. Under the reading curriculum described by Fletcher and Suppes only two minutes of practice in the vocabulary strand are provided in each session.

Hansen, Dick, and Lippert (1968) reported results of implementing college level instruction in CAI for physics. Three groups of students were compared: students receiving the bulk of instruction by CAI, students receiving partial CAI and partial classroom instruction, and students receiving only classroom instruction. Sums of the midterm and final examination scores for all the students revealed significantly superior performance by the autonomous CAI group.

An interesting analysis on some similar data by Hansen, et al. corroborated the subjective impression of many investigators that an important effect of CAI is to truncate the distribution of lower scores. In other words, CAI may provide that very few students are "lost" as they may be under the best of classroom teachers; all students are brought up to some minimal level of mastery.

Adams (1969) and Morrison and Adams (1969) described the results of experiments conducted over two years in using CAI to present introductory German. Students were matched on the basis of the Modern Language Aptitude Test and a random member of each pair was assigned to a CAI presentation of the German course. There was little sacrifice of the performance of CAI students in listening and speaking German, and they performed significantly better on tests of reading and writing achievement.

Bitzer and Boudreaux (1969) report a substantial savings in time when CAI is used to present a given amount of subject material. The information presented comprised a course in maternity nursing given to 38 students. Eighty-four hours were required for standard lecture presentation of the course, and a maximum of 50 hours were required for CAI presentation.

Castleberry and Lagowski (1970) described the use of CAI in presenting a chemistry course. The CAI subjects achieved significantly higher scores on the portions of the final examination that covered material presented by CAI. There was no difference between CAI and non-CAI groups on those portions of the examination that covered material presented to both groups using classroom instruction.

Edwards and Judd (1972) reported an evaluation of a course in special education for undergraduates. Students were randomly assigned to one of three groups. One group received a course handbook and participated in a discussion section; one group received only discussion sections; and one group received CAI and the handbook but did not participate in discussion sections. The resulting evidence favored the group receiving CAI rather than discussion sections.

Suppes and Morningstar (1970) discuss an evaluation of CAI in college level Russian. First, the CAI course was evidently more motivating than classroom presentation of the same course. Of the students originally enrolled in the CAI course, 73 percent finished all three quarters of the first year, compared with 32 percent of the students enrolled in the classroom presentation of the course. Second, CAI students made significantly fewer errors on the year-end final examination than did students receiving classroom instruction.

The equality of any educational presentation is always of interest. That is to say, it is relevant to ask if only the better or only the poorer students benefited from the presentation, of if it allowed fairly equal gains across all levels of student ability. This aspect is examined by Jamison, Fletcher, Suppes, and Atkinson (1973), and by Fletcher and Jamison (1973). Both papers indicate that CAI is inequality averting and that it provides roughly equivalent gains across all levels of student ability.

Cost is relevant to the discussion of any educational presentation, and in this context it is interesting to note a study by Kiesling (1971) who undertook an investigation of compensatory education programs in the state of California. He concluded that success could be achieved by tailoring future compensatory programs around those that had proven successful. Kiesling estimated the annual cost of a successful program in compensatory education at $200-$300 per year per student in addition to the normal per student school allotment. Given the very conservative estimate of $500 per terminal per month on the Stanford CAI system and assuming that each terminal will serve 25 students per day, the cost of CAI would reach a maximum of $200 per student per year. From a cost standpoint, then, CAI competes quite favorably with other successful compensatory education programs.

The evaluation studies surveyed above comprise a selective sample of research on the effectiveness of CAI. An extensive review of the literature reveals practically no negative findings in CAI evaluations. Nearly all studies reveal a significant superiority of performance under

CAI or a superiority for CAI that does not reach statistical significance. The point to be made is that CAI, carefully developed and properly used, can provide effective, and sometimes dramatically effective, educational results.

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